6

Sea-Serpentism

Olivier Rieppel

6.1 Introduction: The Genesis of a Myth

On 2 June 1849, the *Scientific American* (volume 4, p.290) reported news of a sea serpent sighting: '. . . the clipper ship Sophia Walker, Captain Wiswell, was chased around Cape Horn by an enormous sea serpent, half a mile long, and that Captain Wiswell was so terrified that his eyes stuck out far enough to hang a Quaker's hat upon.' A summary of sea serpent sightings dating back to 1895, published in the 12 October issue of the *Scientific American* of that year, specified that the creature 'always remains at the bottom of the sea except in July and August, when it makes its appearance at the surface of the water . . . One will doubtless not fail to remark that the sea serpent has selected just those two months in which newspapers most suffer from a dearth of news!' Indeed, a modern statistical analysis confirmed: 'sea-serpent sightings do tend to be a summer phenomenon', although the idea that this was due to a dull season of the year was found to be 'difficult to test' [1: p.301].

Perhaps the earliest and most famous appearance of the sea serpent is on the *Carta marina* drawn by Olaus Magnus (1490–1557), a catholic priest who, following the conversion of his native Sweden to Lutheranism, sought exile in Rome. In 1527, Olaus began work on a map of northern Europe (mostly Scandinavia), which he completed in 1539 [2]. The *Carta marina* is the earliest, more or less correct map of northern Europe, which Olaus enriched and explained through a commentary book, *Historia de Gentibus Septentrionalibus* (History of the Northern People), first printed in Rome in 1555 [2]. The sea in Olaus's map was populated by all kinds of mythical creatures, amongst them two sea serpents located near the coast of Norway. The more northern one of these he identified, in the key to his map, as 'A worm 200 feet long wrapping itself around a big ship and destroying it'; the smaller southern one shown in a location near Bergen he identified as 'A sea snake, 30 or 40 feet long' [2: p.12]. A remarkable detail concerning the smaller southern sea serpent is that it is shown to propel itself forward through vertical undulations

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of its body, not sideward undulation as eels, or true snakes, would do. In his commentary book, Olaus was more explicit:

> They who in works of navigation on the coasts of Norway employ themselves in fishing or merchandise do all agree in this strange story, that there is a serpent there which is of a vast magnitude, namely 200 foot long, and moreover, 20 foot thick; and is wont to live in rocks and caves toward the sea-coast about Berge: which will go from his holes on a clear night in summer, and devour calves, lambs, and hogs, or else it goes into the sea to feed on polypus (octopus), locusts (lobsters), and all sorts of sea-crabs. He hath commonly hair hanging from his neck a cubit long, and sharp scales, and is black, and he has flaming, shining eyes. This snake disquites the shippers; and he puts up his head on high like a pillar, and catcheth away men, and he devours them . . . (translation from H. Lee [3: p.56]; also translated in Pontoppidan [4: p.208], who disputes the occurrence of the beast near Bergen; see also Oudemans [5: p.10], for a slightly more modern translation).

6.2 The Proliferation of a Myth

Olaus Magnus's report on sea serpents off the coast of Norway made it promptly into the *Historia Animalium*, published by the famous Swiss physician and naturalist Conrad Gesner (1516–1565) in Zurich in 1558 [6]. Gesner [6: p.1040] illustrates both sea serpents that appear on Olaus Magnus's *Carta marina* in mirrored woodcuts, the smaller one again displaying distinct vertical undulations of its body as it moves forward, the other one coiling its massive body around a ship while snatching a sailor off of it. Gesner writes of Olaus Magnus's sea serpent that it:

> . . . sometimes appears near Norway in fine weather, and is dangerous to sea-men, as it snatches away men from the ships. Mariners tell that it incloses ships, as large as our trading vessels . . . It sometimes makes such large coils above the water, that a ship can go through one of them . . . (translation from Oudemans [5: p.107]).

It has been argued that sea serpent sightings multiplied following the publication, in 1755, of the English translation of Erik Pontoppidan's (1698–1764) *The Natural History of Norway* [7]. There, Pontoppidan [4: p.195–196], Bishop of Bergen, wrote: 'The Soe Ormen, the Sea-Snake, *Serpens Marinus Magnus* . . . is a wonderful and terrible Sea-monster, which extremely deserves to be taken notice of by those who are curious to look into the extraordinary works of the great creator'. Most significantly, the sea serpent described and illustrated by Pontoppidan again propelled itself forward by vertical undulation of its body (Fig. 6.1). Pontoppidan [4: p.206] describes 'round lumps' or 'folds' that are visible when a sea serpent surfaces, and goes on to cite the German Scholar Adam Olearius (1599–1671), who in his '*Gottdorf Museum*' wrote: '. . . [in] the North sea, he saw in the water, which was very calm, a Snake, which appeared at that distance to be as thick as a pipe of wine, and had 25 folds' (Olearius [8: p.19]; translation from Pontoppidan [4: p.207]). Pontoppidan then goes on to surmise that the number of folds that 'may be counted on a Sea-snake . . . is not always the same, but depends on the various sizes of them' [4: p.207].

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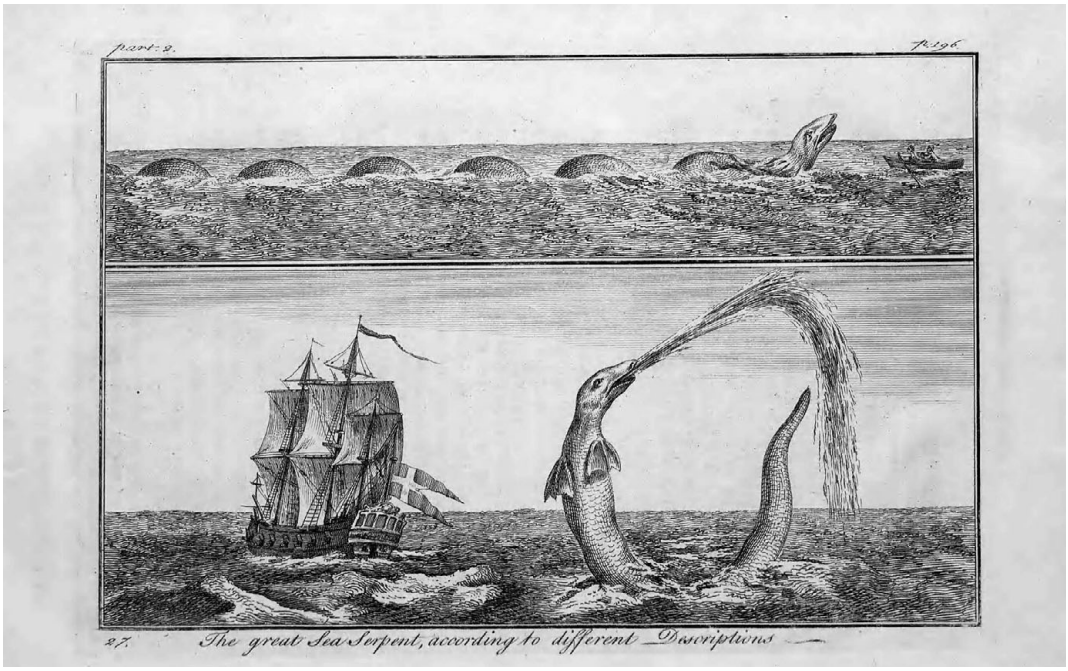

Figure 6.1 The Great Sea-Serpent, reproduced from Pontoppidan [4: plate 27].

6.3 The Scientific Approach to a Myth

The various sea serpent sightings reported throughout the nineteenth century have been collected and commented upon by Oudemans [5]. Here, only one of the most notorious cases will be recounted, involving a pathological specimen of the common black racer (*Coluber constrictor*) with a series of bumps along its back found near Gloucester, Massachusetts [9, 10]. The Gloucester Sea Serpent was first spotted near Cape Ann when it entered Gloucester Harbor on 6 August 1817, 'in pursuit of shoals of fishes, herrings, squids, &c. on which it feeds. Its motions are very quick; it was seen by great many, but all attempts to catch it have failed, although $5000 has been offered for its spoils' [11: p.433].

> In the month of August 1817, it was currently reported on various authorities, that an animal of very singular appearance had been recently and repeatedly seen in the harbor of Gloucester, Cape Ann, about thirty miles distant from Boston. It was said to resemble a serpent in its general form and motions, to be of immense size, and to move with wonderful rapidity; to appear on the surface of the water only in calm and bright weather; and to seem jointed or like a number of buoys or casks following each other in a line. In consequence of these reports, at a meeting of the Linnean Society of New England, holden at Boston on the 18th day of August, the Hon. John Davis, Jacob Bigelow, M. D., and Francis C. Gray, Esq.

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> were appointed a Committee to collect evidence with regard to the existence and appearance of any such animal.

Such opens the *Report of a Committee of the Linnean Society of New England, relative to a large marine animal, supposed to be a serpent, seen near Cape Ann, Massachusetts, in August 1817*, published in 1817 by Cummings and Hilliard in Boston (hereafter referred to as *Report* [12]). Eye-witnesses who claimed to have spotted the Sea Serpent were confronted with a list of questions drawn up by the Committee, and asked to testify under oath. The committee members were identified as 'men of fair and unblemished character in Gloucester' by one commentator [13: p.89], who also surmised that the classic summertime appearance of the Gloucester Sea Serpent may be explained by it being 'migratory, like the Coluber Natrix in Hungary, and may pass the winter season in Mexico or South America' [13: p.91]. The leading British geologist of the time, Charles Lyell (1797–1875), when commenting on the Gloucester Sea Serpent investigation, likewise emphasized: 'I am well acquainted with two of the three gentlemen' on the committee [14: p.111].

The various reports delivered to the Linnean Society committee were not entirely free of contradictions: 'These two points – the vertical or horizontal nature of the creature's undulations when moving, and the apparent 'bunches', or serrations exhibited by the outline of its back – seem to have formed rather a bone of contention among both the observers and the Committee' [15: p.39]. With much hindsight, Gould [15: p.40] wrote with reference to the putative vertical undulations of the Sea Serpent, 'the structure of its backbone must have been truly astonishing – it must have looked like a series of universal joints'. Because the Gloucester Sea Serpent was never caught or killed, it was at the time an unexpected opportunity to investigate the matter when on 27 September 1817, a small black snake was caught and killed 'in a field near Loblolly cove, about a mile and a half from Sandy Bay village' (*Report* [12: p.44]). The little black snake was brought to Boston for the Linnean Society committee members to inspect it: 'The animal had the general form and external characters of a serpent; but was remarkably distinguished from all others of that class known to your Committee, by a row of protuberances along the back, apparently formed by undulations of the spine' (*Report* [12: p.38]). The specimen was consequently named a new genus and species, *Scoliophis atlanticus* (the 'flexible Atlantic snake'). The committee members recognized the similarities the specimens shared with the common black racer (*Coluber constrictor*), a snake frequently seen in this area, but insisted that it differed 'strikingly . . . by its undulating back' (*Report* [12: p.38]). Part of the specimen was eventually dissected in an attempt to clarify the functional anatomy of the vertebral musculoskeletal system in vertical undulation: 'The structure of the *spine* is very singular, and different from that of any serpent we have seen, or known to be described . . . The structure of the different vertebrae varies to accommodate itself to this configuration [i.e., vertical undulation], so that the spine cannot be extended into a straight line without dislocation of its parts' (*Report* [12: p.40]). In a footnote to those observations, the committee added: 'This is the reverse of what Cuvier asserts of serpents in general' (*Report* [12: p.41]) – Georges Cuvier (1769–1832), of course, being the famous palaeontologist and functional and comparative anatomist at the National Museum of Natural History in

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Paris. Cuvier's younger counterpart in Britain, Sir Richard Owen (1804–1892), would eventually side with the latter, however. In his account of the anatomy of the ophidian vertebral column, Owen noted: 'there is no natural undulation of the body upwards and downwards, it is permitted only from side to side. . .' [16: p.153].

Considering the snake with the bumpy back and its unique vertebral column to represent a new species, the committee members introduced it under the name *Scoliophis atlanticus*. Justice of the Peace Lonson Nash from Gloucester, who testified in front of the committee, was not alone in presuming the 'young' serpent 'to be the progeny of the remarkable Sea Serpent, that was so often seen in the harbour', and assured his audience: 'Should it thereafter be ascertained, that the great serpent has been seen on land here, I shall take the earliest opportunity to inform you of a fact, so important' (*Report* [12: p.46]). The assumption motivating this expectation was, of course, that the Sea Serpent would deposit its eggs on land in sandy soil near the shore, as modern sea turtles do.

In contrast, the French zoologist H. de Blainville (1777–1850) pointed out that *Scoliophis atlanticus* was identical with the common black racer (*Coluber constrictor*), except for its bumpy back. With respect to the conclusion that the small snake found on land should be an offspring of the animal seen in the sea – 'the probability diminishes to almost completely zero' [17: p.304]. This highly skeptical position was confirmed by the French naturalist and explorer Alexandre Lesueur (1778–1846), who inspected the little snake with the bumpy back from Loblolly cove, and compared it with *Coluber constrictor*. He found no characters in the external appearance of *Scoliophis* that would justify its recognition as a separate genus, and when it came to the vertebral column in a section of the body forming a bump, he observed: 'the vertebrae that constitute this part show a high degree of irregularity and indeed a notable deformation . . . I have no doubt whatsoever that this represents a totally anomalous condition; perhaps the individual received a series of blows in its youth . . .' [18: p.468]. Commenting on what became known as the *Scoliophis* 'hoax', the leading British Geologist Charles Lyell noted of the New England Linnean Society committee: 'Just as they were concluding their report, an unlucky accident raised a laugh at the expense of the Linnean Committee, and enabled the incredulous to turn the whole matter into ridicule' [14: p.112]. The 'accident' was the finding of the Loblolly cove serpent: 'It had a series of bumps on his back, caused by the individual happening to have a diseased spine' [14: p.112]. Indeed, during his travels in the United States, Lyell had realized what impact the Gloucester Sea Serpent saga had had on the broader public: 'After the year 1817, every marvelous tale was called in the United States a snake story . . .' [14: p.113].

6.4 Names Change Meanings: The Myth Turns Real

Every incredible tale was called a 'snake story'; evidently, the term 'snake' no longer referred to snakes only in this context, but to whatever the 'marvelous tale' was about. A similar looseness of meaning became increasingly apparent with respect to the term 'sea serpent', which no longer referred to a giant marine snake only, but to any monstrous, unidentified animal spotted in the sea. The October 19, 1850 issue of the *Scientific American*

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reported: 'a large sea serpent has been seen in the Penobscot Bay . . . It is not known to what species of fish this monster belongs, neither is it improbable that in ancient times it was known as the 'leviathan' . . .' The 27 December 1879, issue of the *Scientific American* described how a giant octopus could create the appearance of a 'hydrophidian or marine serpent.' In the 19 March 1887 issue of the *Scientific American*, an anonymous letter writer professed: 'It has been my belief for some years that there is some fitful gigantic wanderer inhabiting the ocean . . . I think it is the sea serpent . . . I shall not attempt to classify it. Whether it belongs to the mammalia, reptilia, or pisces, whether it be ophidian, cetacean, or saurian, I must leave it to the naturalist to determine.' On 31 December 1892, the *Scientific American* reported a sea serpent sighting by the crew on the Liverpool mail steamer *Angola*, and concluded: 'As is usual in cases of the kind, the signatories have been subjected to a great deal of ridicule, but they are nevertheless convinced that the monster they saw was a marine mystery and a sea serpent.' The Inspector of Fisheries Frank Buckland concluded: 'It is, therefore, evident to my mind that the coast of Norway and the north of Scotland are occasionally visited by a living creature, which, for want of a better name, is called 'The Great Sea Snake'' [19: p.411].

In 1892, the Director of the Zoological Garden at the Hague, Anthonie Cornelius Oudemans (1858–1943) published his major treatise on *The Great Sea-Serpent* [5], of which an anonymous review in *Nature* stated: 'It is impossible, however, to treat this laborious work as a scientific treatise.' And yet: 'Enough has been written [on sea serpents] to prove that this volume is not without a certain amount of interest . . . to open its pages at random one is sure to be arrested by some startling phase of belief or by some marvelous narration . . .' [20]. Oudemans [5] chronologically listed and analysed reports of sea serpent sightings, carefully trying to discern phantasy from fact. Commenting on Conrad Gesner's [6] account of Olaus Magnus's sea serpent (see above), Oudemans [5: p.109] wrote: 'Here we meet with three other characteristics of the sea-serpent: it is harmless when not provoked, it encircles ships and turns them upside down, and its coils are so gigantic that a ship can go through one of them. The first characteristic is a real one: the sea-serpent is perfectly harmless. . .,' the other characterizations he deemed exaggerations. Of the *Report of the Committee* of the Linnean Society of New England, Oudemans [5: p.163] stated in support of the existence of the Gloucester Sea Serpent: 'We observe that the Linnean Society has exerted all its energies in the matter and has acted with greatest accuracy.' But what, in Oudemans's opinion, *is* the sea serpent, which he proposed to name – following Rafinesque [11] – *Megophias megophias*? 'It will be quite superfluous to tell my readers to which order of animals I think that this *Megophias megophias* belongs. It runs like a red thread through my whole volume, that I firmly believe that it belongs to the order of *Pinnipedia*' [5: p.546] – i.e., it resembles a sea-lion [5: p.568].

6.5 The Real Sea Serpent

In contrast to Oudemans's conclusion, the fossils of marine Late Cretaceous reptiles – the mosasaurs – had for some already become the material basis of real sea serpents. The

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Philadelphia-based paleontologist Edward Drinker Cope (1840–1897) is perhaps best known for his engagement in the dinosaur 'Bone Wars' against Yale paleontologist Othniel Charles Marsh (1831–1899). These played out in the American West during the 'Great Dinosaur Rush' that lasted from 1877 through 1892. In the year 1869, Cope published in the *Proceedings of the Boston Society of Natural History* a paper titled 'On the reptilian orders Pythonomorpha and Streptosauria' [21]. What is of interest here is the name Pythonomorpha (see Polcyn et al., Chapter 7), which translates as 'reptiles that resemble pythons in their anatomy'. Cope [21: p.258] included two families in his Pythonomorpha, the Clidastidae and Mosasauridae, the latter two colloquially referred to as mosasaurs, marine reptiles from the Late Cretaceous. By the end of the Cretaceous, mosasaurs had ascended to the apex of the marine food-chain, many species exceeding four meters (13 feet) in length. Cope [21: p.262] himself described the fossil remains of a very large mosasaur as those of a new species, *Mosasaurus maximus* [see also 22: p.189]. Today, this species is treated as a junior synonym of *Mosasaurus hoffmannii* [23], famously the very first mosasaur to have ever been collected, at St. Pietersberg south of Maastrich (the Netherlands) between 1770 to 1774 [24]. The estimated total length reached by that species, based on new material of *Mosasaurus hoffmannii* from Penza (Russia), is 17 meters (55 feet) [25].

When reviewing the anatomy of mosasaurs, Cope [21] noted that they share a number of characteristics with lizards, but more interestingly they also share many characteristics with snakes. One of the most striking snake characters in mosasaurs concerns their lower jaw: 'The mandibular arch is very much like that of serpents' [21: p.255]. In lizards, as in all tetrapods, the dentary bones in the right and left mandible meet anteriorly in a syndesmotic suture (that may co-ossify in the adult, as in mammals). In mosasaurs and snakes, there is no mandibular symphysis, permitting the left and right mandible to move independently from one another. Another striking feature shared by snakes and mosasaurs is a joint in the middle of the mandible, between the dentary and the postdentary bones, allowing for further mobility and expansion. This led Cope [21: p.157] to conclude that mosasaurs' 'habit was to devour [their prey] whole', as snakes do.

> 'From the preceding evidence, we may look upon the mosasauroids and their allies as a race of gigantic, marine, serpent-like reptiles, with powers of swimming and running, like the modern Ophidia. Adding a pair of short anterior paddles, they are not badly represented by old Pontoppidan's figure of the sea serpent ... Thus in the mosasauroids, we almost realize the fictions of snake-like dragons and sea serpents, in which men have been ever prone to indulge. On account of the ophidian part of their affinities, I have called this order the Pythonomorpha. ([21: p.257–258]; see also Fig. 6.1)

Cope's account of the Pythonomorpha was subsequently scrutinized by Owen, a critique which Cope [26] answered in a lengthy rebuttal. In it, Cope once again stressed his conclusion 'that the *Pythonomorpha* are nearer to the *Ophidia* than are the *Lacertilia*' [26: p.310]. Owen [27: p.714] criticized Cope for having claimed that the mosasaur represents 'a marine animal, scientifically entitled to be called 'serpent' ... unless the 'great sea serpent' of our newspapers should establish its claims for admittance into the scientific

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catalogue.' Interestingly, in his reply Cope invoked the indeterminacy of meaning of the term 'sea serpent' again: 'As to the use of the term sea-serpent, since I have not referred these reptiles [i.e., the pythonomorphs] to the *Ophidia*, the term involves no error' [26: p.310].

6.6 The Sea Serpent's Legs

In a book review titled *The Serpent World*, Shine [28: p.1946] regretted: 'Unfortunately, Lee and Caldwell's work on the fabulous missing link (*Pachyrhachis*, 'the snake with legs') was published too recently for inclusion in the book.' What is meant here is the re-description by Caldwell and Lee [29] and Lee and Caldwell [30] of the fossil snake *Pachyrhachis problematicus* from marine sediments of mid-Cretaceous age, found near Ein Yabrud in the Judean Hills (West Bank, Middle East). The remarkable thing about this fossil snake is that it has small, but well-developed hindlimbs. On account of those limbs, it had already been praised as an 'almost ideal intermediate' between varanoids and snakes in what at that time was the standard textbook on Vertebrate Paleontology [31]. Caldwell and Lee's [29, 30] cladistic analysis supported this interpretation of *P. problematicus*, more specifically linking the 'snake with limbs' to mosasauroids, a clade of Cretaceous marine (anguimorphan or varanoid: Augusta et al., Chapter 8; but see [32]) squamates. Eventually, Cope's pythonomorph scenario, now cast in the light of the step-wise evolution of macrophagy in mosasaurs and the descendant snakes, was re-invented by claiming mosasaurs to 'represent a crucial intermediate stage' in the origin of snakes not from 'small burrowing lizards, as commonly assumed, but [from] large marine forms' instead [21, 33: p.655–656].

Doubts were soon cast on such identity of *Pachyrhachis* [34], later fueled by the discovery of two additional taxa of marine snakes with well-developed hindlimbs from the mid-Cretaceous of the Middle East (*Haasiophis* [35, 36] and *Eupodophis* [37, 38]). At the bottom of the dispute lies the question: are these marine 'snakes with limbs' the perfect missing link between snakes and mosasauroids, or are they more advanced snakes nested firmly among crown-group alethinophidians? The latter scenario implies, however, that limb reduction in basal snakes either occurred repeatedly [39], or alternatively, and more parsimoniously, that the hindlimbs in these mid-Cretaceous marine pachyophiid snakes would have re-developed from meager rudiments still present in their ancestors (see discussion in [35] and Zaher et al., Chapter 9).

One pioneering study of the developmental mechanisms underlying the evolution of the snake body plan is that of Cohn and Tickle [40]. Their study addressed the genetic basis of body regionalization, rather than body elongation per se, and how the development, or loss, of limbs is correlated with the axial regionalization (compartmentalization) of the body [41]. The postcranial body axis of a generalized tetrapod (think of a quadrupedal lizard) is compartmentalized into the neck, trunk and tail. On the boundary between neck and trunk are located the pectoral girdle and the forelimbs. On the boundary between trunk and tail are located the pelvic girdle and the hindlimbs. Cohn

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and Tickle [40] could show that the expression pattern of certain so called *Hox* genes sharply demarcates the neck from the trunk in tetrapods, thereby also specifying the identity of neck and trunk respectively. Gene expression patterns in a python indicated that in snakes, the identity of the trunk has been extended anteriorly up to the very first neck vertebra (atlas). That is to say, the ancestral neck in snakes has become thoracalized, although it is not entirely clear that the snake precloacal axial skeleton lost all signs of regionalization [42–44]. In the absence of the boundary zone signal between the ancestral neck and trunk there is no trace of a pectoral girdle or forelimb rudiments in any snake known, fossil and extant, nor do anterior limb buds sprout from the lateral body wall in any snake embryo (*Tetrapodophis*, an enigmatic fossil squamate from the Early Cretaceous of Brazil combines snake-like features with well-developed fore- and hindlimbs: [45]). The hindlimbs, on the other hand, are not affected through the thoracalization of the ancestral neck, and start to sprout from the python body wall, forming embryonic limb buds. But here again, certain molecular signals that structure limb development in a normal tetrapod (e.g., a quadrupedal lizard) are suppressed in the python limb bud, and the tissue in which these signals originate degenerates. Hindlimb development is thus truncated at an early stage in python. The result is that only a rudimentary femur develops. The chemical signals that fail to sustain the python limb bud growth and full-term morphogenesis are in large part mediated by Sonic hedgehog and fibroblast growth factors. When such growth factors are artificially inserted into the python limb bud, the latter was found to be thereby stimulated to grow to larger size than would be normal [40: p.476].

In a further follow-up study, even greater scrutiny was brought to bear on the analysis of limb reduction in pythons and boas [46]. Among a number of experiments the study also targeted the expression of a gene called *SOX9* in the python hindlimb bud. *SOX9* is a protein-coding gene that plays a regulatory role in skeleton formation (and also sex determination). As such, '*SOX9* expression in python hindlimbs delineates discrete skeletal condensations', initially marking out 'pre-chondrogenic skeletal condensations' of a 'Y-shaped domain' [46: p.2971]. This is, indeed, a classic stage of limb development in all tetrapods, where at an early stage both in the fore- and hindlimb the early cartilage condensation is in a Y-shaped form from which, in the hindlimb, the precursors of the femur, tibia and fibula differentiate [47]. Ultimately it proved possible to identify, in the python hindlimb bud, three discreet *SOX9* expression domains 'that resemble the three major segments ... of the tetrapod limbs', and hence 'could be anlagen of the femur, tibia and fibula, and digital plate' [46: p.2971]. The upshot of this finding is 'that python embryos develop transitory cartilage condensations of the lower leg and foot', suggesting 'that re-acquisition of fully developed hindlimbs in extinct snakes may not have required de-novo re-evolution of lost structures, but could have resulted from persistence of the embryonic legs' [46: p.2971]. In summary, the 're-acquisition of complete limbs in some extinct snakes could have resulted from activation of a largely intact but dormant limb developmental program in snake embryos' [48: p.9]. The re-development of limbs from ancestral limb rudiments in squamates is thus a distinct possibility (see also [49]).

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6.7 Conclusion

The snake is a powerful symbol of birth, death, and rebirth in mythology, alchemy, and psychology. In mythology, the snake resides either deep underground, or deeply submerged at the bottom of the sea or other bodies of water. In evolutionary biology, the classic scenarios concerning snake origins that have been identified by Lee et al. [33] in their sketch of the pythonomorph scenario are either from small, secretive or even burrowing lizard-like forms, or from large, marine macrophagous forms such as mosasaurs. The first scenario, the origin of snakes from small, burrowing lizard-like forms, was recently branded as a myth [50]. But sea serpentism is deeply steeped in mythology as well (see discussion in [51]). And either scenario is at odds with the squamate tree of life based on genomic data, where snakes come out as sister-group to a clade that comprises the sister-taxa Iguania and Anguimorpha [52–54]. Snakes, fossil and extant, have to this day not conclusively revealed the secret of their place of birth. To lift the veil that shrouds the evolutionary origin of snakes will require continued careful and unbiased morphological study, as well as a willingness to confront the issue why genomic data [53] yield a pattern of higher-level squamate relationships that is so fundamentally different from the tree based on morphological data [32], and counterintuitive as well (with dibamids at its base). It is fair to say that from a philosophical perspective we may never obtain certainty in our knowledge of snake origins, but we know one thing for certain: that the morphological and genomic data yield fundamentally incongruent trees of higher-level squamate relationships. It is time to ask the question why this should be so.

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